# MTM

THE JOURNAL OF METHODS-TIME MEASUREMENT

Jan-Feb

1956

Vol. II

No. 5

*In This Issue . . . . .*

Research and MTM

Training New Operators

MTM Standard Data for Assembly Operations

MTM Standards for Picking, Checking and Packing Patterns

MTM ASSOCIATION FOR STANDARDS AND RESEARCH

The Journal of Methods-Time Measurement is dedicated to the technical aspects, application developments and general news items concerning the advancement of MTM.

The Journal encompasses the fields of endeavor that were formerly publicized in the MTM Newsletter and MTM Bulletin.

The technical section of the Journal is concerned chiefly with recent research developments both from the established research program at the University of Michigan, Ann Arbor, Michigan, and from somewhat smaller allied projects being conducted throughout the Association membership.

New applications of MTM as well as refinements of established applications are presented in the Application Section to illustrate specific approaches to management problems that can be solved through the use of Methods-Time Measurement.

Current events in the lives of persons associated with MTM are described in the general news section.

The Editorial Staff welcomes contributions for all three sections described.

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# MTM

THE JOURNAL OF METHODS-TIME MEASUREMENT

MTM ASSOCIATION FOR STANDARDS AND RESEARCH

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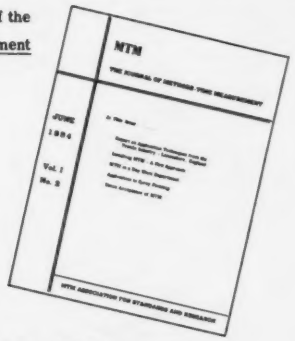


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# TECHNICAL

## RESEARCH AND MTM

David L. Raphael, Research Associate
Engineering Research Institute
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Ann Arbor, Michigan

An engineering technique such as a predetermined time system, if it is to remain a vital and effective tool, cannot stand still, cannot remain fixed and unchanged. It must be capable of expansion and improvement. It must be changed to meet the changing demands which will be made of it.

Methods-Time-Measurement, of course, is no different from any other such system. If it is to remain an effective industrial engineering tool, it must be continually improved and enlarged to meet the constantly changing and growing array of industrial problems to which the engineer seeks solutions. If it is not so improved and enlarged, it must eventually fall into discard as a usable technique.

With this situation in mind, the original developers of MTM, and the members of the MTM Association ever since, have continually and consistently joined together the proper application of MTM as it now exists with what MTM must become in the future. Thus, since the beginning of the Association, standards of application have been inextricably joined with motion research. The changing problems of application have instigated a continuing research program. This program has brought about modification and improvement of the application data and an enlargement of our knowledge of the characteristic behavior of human motions. What has resulted is an ever-growing and improving MTM system, firmly rooted in a soil of research which nurtures its growth and development.

Research performs its function of keeping MTM an improving and effective tool in two ways. *First*, through basic research projects in general MTM motion areas such as Simultaneous Motions. This provides information on the characteristics of the motions being studied, and the validation or correction of the present MTM application data. A good example of this is the recently completed study of moves with weight. This provided a fairly complete understanding of the characteristic behavior of movements involving weights as well as a new set of weight allowance data which has been incorporated in the Data Card. *Second*, through new and unexpected bits of research information which emerged from the welter of research analysis. These bits are unplanned and represent a byproduct secondary to the main purpose of a research project. Often they are fragmentary and incomplete. They merely point to new, possibly valid, application methods which must be verified both in actual practice and by further investigation through research. They, however, serve a vital dual purpose, that of providing possibly useful data to the MTM practitioner, which he may test and try, and of indicating fruitful directions in carrying out MTM research.

I should like to discuss and illustrate both of these aspects of the research function. This will not only demonstrate the points of our discussion but will also provide you with a report on the present status of research activity and several possibly helpful bits of information which might be useful in your present work.

### *BASIC RESEARCH PROJECTS*

A good example of a basic MTM research project is the one in which the basic motion element "Position" is being investigated. This is the project now in process at the Association's research facility at the University of Michigan and I should like to set out in some detail what was actually involved in proceeding with this project. It is a basic requirement that our investigation adequately cover the area being studied in an objective and scientifically valid manner. This project has to yield two results:

1. A comprehensive picture of the subject, detailing the effect of the important variables. This will make possible the analysis of "Position" in specific, clear and meaningful terms.

2. Accurate estimates of performance times and practical methods of handling the "Position" element in application.

Because of the large number of variables involved, it was almost impossible to collect a reasonably balanced sample of research data from industrial operations. Therefore, a controlled laboratory operation was used to provide a balanced experimental design. It consisted basically of moving and positioning an object to a destination. Six different shapes of object, and two different materials, steel and wood, were used. The objects were positioned to destinations of three degrees of fit. The objects were engaged over three different distances. Positions were performed where no orientation, and maximum orientation were required. This already gives us

216 different unique variations in positioning. Since these combinations were performed several times each, by eight operators, and since additional factors such as the degrees of restriction to positioning (i.e., placing a square object in a square and a rectangular hole) were also included, the volume of data to be collected becomes quite large. It would require an immense effort to collect all this data in a balanced form from industrial operations. Yet they are all necessary to provide a meaningful set of conclusions on the behavioral characteristics of Position.

But, since laboratory data is suspect as far as providing applicable performance times for Position, a large random sample is also being collected from actual industrial operations. This industrial sample, the analysis of which will be aided by the information provided from the laboratory study, will be used to develop performance times for the Position element for use in validating or replacing the present data.

This then indicates the complexity of our task. To date we have 3,300 feet of film covering the laboratory operation. Accurate frame by frame analysis of this film is now being made. 200 feet of film of industrial operations are on file and much more is planned in the near future. In addition, approximately 250 Positions, available from previous projects, have been analyzed statistically but are only of limited corroborative value.

### *APPLICATION AIDS*

Let us now consider the other aspect of research results, those pieces of incomplete information which appear as a byproduct out of a basic research investigation. I should like to present three examples. They illustrate the type of information I have been referring to in general terms, and also are possible application aids for the practitioner to try and to test. Towards this end, how and where they might be found useful will be discussed.

Before discussing the research material directly, I should like to review certain characteristics of Methods-Time-Measurement. These characteristics point up the sort of situation to which the material presented should apply.

MTM time values are, in general, statistical averages, tested for reliability, and developed from samples of industrial motions of the type they are expected to represent. The samples of motions were collected in a random manner from what is hoped to be a balanced cross section of typical industrial operations. They are expected to apply, and most successfully are applied, to operations which can be considered as belonging to a usual or normal range of industrial operations. They are not exact true times for every motion in any operation. Rather, they are approximations and best estimates, which to a greater or lesser degree reflect the correct performance time of a motion in a given operation. Since they are averages of motions in a range of typical operations, they will approximate, when applied, more accurately the motion times of the same or similar types of operations.

From this is it easy to see that operations in which extreme or peculiar conditions hold might present difficulties in MTM analysis. MTM was not primarily developed to handle the atypical operation. This can only come as our background of information is enlarged and extended. Thus, operations in which one type of motion predominates or in which some atypical peculiarity prevails have always presented problems to the MTM practitioner. Many of you in the audience today would readily testify to this.

The material to be presented addresses itself to this type of situation. In general, extreme or special conditions are inadequately handled by MTM data. This is because such conditions require a level of accuracy unnecessary in the usual MTM operation. If, in one operation, some motion occupies 50 per cent of the cycle time and only 2 per cent of another, it is obvious that a time value sufficient to approximate only 2 per cent of a cycle might be very inadequate in approximating 50 per cent of a cycle. The time value used in this last case must be extremely accurate in order to prevent errors from piling up. In the 2 per cent case, errors involved in a less accurate time value would still remain small and would tend to be compensated for by opposite errors in the MTM times of other motions of the operation.

I should like to discuss now some of the information which the research activity has to offer as an aid to handling these extreme or special conditions in application.

### *MOVING WEIGHTS – OPTIMUM DISTANCES*

One interesting aspect of the movement of weighted objects is the natural and comfortable pattern taken by industrial operators in accomplishing such a task. Though requirements of an operation or the nature of the workplace tend to force and determine how far an object must be moved, operators consistently followed a pattern in which the weight moved was inversely related to the distance moved. That is, operators consistently reduced the distance of movement as the weight of the object moved increased. Of course, this is a rather logical thing to expect. The implications of it are of some importance.

Such behavior implies that for a given weight there exists an optimum distance such that (1) movement of the weight over distances less than or equal to this optimum would be comfortable, easy, and only norm-

ally fatiguing, and (2) movement of the weight over distances greater than this optimum would be awkward, difficult, and cause over-rapid fatigue. This means that an operator required to perform at distances greater than this optimum will not be able to perform at a reasonable level of efficiency. This means that normal performance expectations in the form of MTM performance time values would not validly apply. The operator is essentially being asked to work in a manner both abnormal and difficult. See Exhibit 1. This chart illustrates the pattern we have been discussing. It is a weight vs. average-distance plot based on a large sample of moves with weight, performed by industrial operators. Note that, as was stated before, as the weight moved increases, the average performance distance decreases. In a rough sense, this curve could be considered as an estimate of the optimum performance distances for the range of weights involved. That is, we could use the curve portrayed here to determine what range of distances we could reasonably expect an operator to use in moving a given weight, and still meet standards of normal performance.

For example, for a weight of ten pounds the curve gives an average distance of approximately 10 inches. If some operation required the movement of such a weight, then it would be best to devise a workplace and develop a method which would only require the operator to move the weight approximately 10 inches or less.

This curve then could be used as a valuable methods aid. Distance values taken from it, however, should only be treated as a rough estimate of the optimum performance distance. Used properly it should help in the prevention of awkward and over-fatiguing movements of weight.

### *MOVES WITH WEIGHT – RELEASE LOAD*

As you know, the movement of an object of considerable weight consists of a static and a dynamic component. The static component refers to the time required, after the fingers have grasped the object, for the hand and arm to take up the weight of the object and have it under control for the subsequent movement. At the end of the movement the object is released. See Exhibit 2. On this chart is shown the effect on release time as the weights moved increased. This is a time vs. weight plot of a large number of such release loads. The critical factor here is the muscle tension built up during the static component of the preceding move with weight. It seems, just as more time is required to build up muscle tension in gaining control of increasingly heavier objects, more time is required to release this tension upon relinquishing the objects.

Since this increase in release time might be critical and important to the successful analysis of certain operations, it has been included in this presentation. It should be of use especially in operations involving a large amount of handling of objects weighing 10 pounds or more. Only in such operations would the time increment on release be of sufficient size and importance. Following is a table of release times which might be used if so desired:

| Weight | TMU |
|---|---|
| 0 - 2.5 | 2.0 |
| 2.5 - 7.5 | 2.3 |
| 7.5 - 12.5 | 2.7 |
| 12.5 - 17.5 | 3.2 |

### *FINGER MOTIONS*

Finally, I should like to discuss the application of MTM to the operation of adding machines, typewriters, and comptometers. The amount and coverage of available research data is quite insufficient to make any full and complete statements concerning proper MTM application. However, the information, though limited, could be of some use.

The available data covers basically a finger movement used to strike or depress a key on an adding machine, comptometer, or a standard manual office typewriter. In MTM this finger movement is analyzed as two motions, a Reach, Case A, in motion at the end for the movement of the finger to the key, and a Move, Case A, in motion at the beginning for the movement depressing the key. The difficulty involved in using present MTM data in analyzing this movement is the fact that the force necessary to depress keys of different machines varies and may cause an additional time increment to complete the movement that is not accounted for in the present MTM data. Though this increment may be small it is crucial since so much of the cycle in operating a machine is made up of such movements.

The available data indicated the following performance times for these movements on standard, manually operated machines:

| | |
|---|---|
| Adding Machines and Comptometers | 1.6 TMU |
| Typewriters (Manual) | 2.0 TMU |
| Data Card | 1.7 TMU |

Note that the times for depressing comptometer and adding machine keys is nearly the time given for such a motion on the MTM Data Card. We can conclude that in the case of operating these machines, the present MTM data is adequate, at least, insofar as depressing the keys is concerned. We should more or less expect this result, since comptometer and adding machine keys have a very light touch. However, in the case of the typewriter, a much more emphatic sort of movement is required. As a result, we see that the time for depressing the typewriter is longer. Further, the difference is a statistically significant one.

From this discussion it would seem logical to attempt MTM analyses in the following manner. In this table are presented two separate analyses; a standard MTM analysis using the data card values and a special typewriter analysis using the different typewriter value. This last value is tentative and only presented to you as a possibility to be tested in practice. If it is valid, its use would be of much importance. For example, typing a 100-word letter would result in a 30 TMU increment in time over the time allowed under standard MTM analysis.

From the Data Card

| | | | | |
|---|---|---|---|---|
| RfAm | 1.6 TMU | R1Am | 2.3 TMU |
| mMfA | 1.7 TMU | mMfA | 1.7 TMU |
| | 3.3 TMU | | 4.0 TMU |

From the Special Values

| | | | |
|---|---|---|---|
| RfAm | 1.6 TMU | R1Am | 2.3 TMU |
| mMfA | 2.0 TMU | mMfA | 2.0 TMU |
| | 3.6 TMU | | 4.3 TMU |

EXHIBIT 1

MEAN PERFORMANCE DISTANCE FOR MOVES IN VARIOUS WEIGHT RANGES

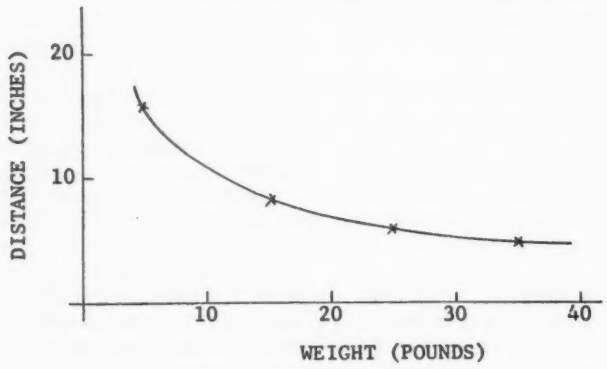
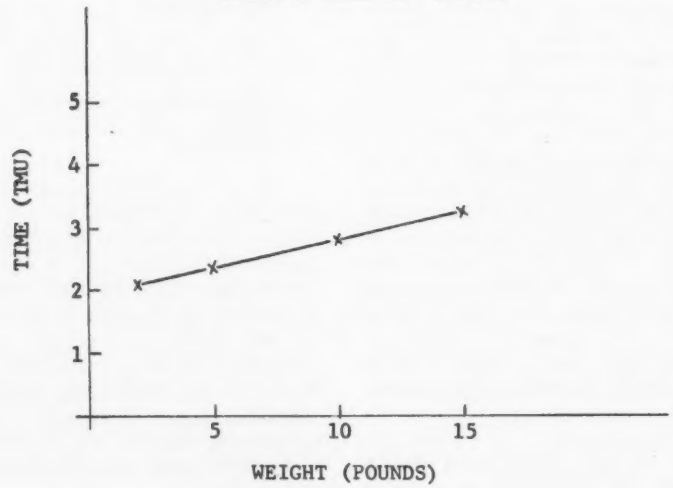



EXHIBIT 2

RELEASE TIME VS. WEIGHT



# APPLICATION

# I

## TRAINING NEW OPERATORS

Mrs. Dorothy Proctor
The Upjohn Company
Kalamazoo, Michigan

Our training program was started approximately 15 years ago under the supervision of the Methods and Standards Department, and, except for one brief interlude, when each Packaging Department undertook the training of their own new employees, it has remained a function of this Department. This reinstatement was done at the request of packaging supervision.

The packaging operators, with whom we are primarily concerned, work on packaging lines according to a rotation system. This means that each operator moves periodically from one job to the next, which often is quite different, and on long runs each operator will work at each job perhaps more than once. This rotation system accomplishes two things which the Company considers important. First it relieves the monotony of working continuously at one job, thus making the work more interesting for the employees. Second it provides supervision with a more flexible group of operators capable of working wherever or whatever job is necessary in any given situation.

This system does require that each operator be capable of performing any job on any line at a standard production speed, and the failure or inability of any one operator to do this can slow down or even stop the entire line. Maintenance of continuous standard production speed is accomplished with a minimum of lost time by instructing all new operators in the correct methods.

The job instruction does not replace in any way the formal induction given each new employee by the Personnel Department and the foreman. It follows and supplements the instructions given by the foremen under whose supervision the employee works. At the completion of the induction period the instructor takes the new employee to the line where she will start, and explains the general work procedure. This serves as a general "get acquainted" and "put at ease" period. Much of the information already given by the foreman may be repeated, but some of it may even have to be repeated again before it is remembered.

At this time the employee is given such information as:

1. The speed of the line and output at standard.

2. What is expected of the new operators. (A "timetable" for learning or how soon she can expect to keep up.)

3. What she can expect from the experienced operators in cooperation and assistance.

4. What the quality of the product and finished package should be. (The inspection is stressed especially.)

5. The rotation system.

6. How materials are supplied.

7. Good Housekeeping requirements.

8. Whom to ask for information concerning the immediate job.

9. An introduction to the Service Man in charge of the line.

10. A chance to observe all the jobs on the line with an explanation of what each accomplishes.

New employees are usually trained in groups, which may vary from 2 to 5 girls, on any one line. This line will include all or most of the basic hand operations plus some automatic and semi-automatic cap tightener, semi-automatic labeler, and hand cartoning with medicine droppers and directional inserts. One of the most difficult bottles to label satisfactorily is selected, such as a 5cc square bottle used in Fluid Packaging. To start the training one section of this line is selected including one rather difficult job, and the rest comparatively simple or easy to learn jobs. This might be the filling and capping end of the line. The new employees rotate on these jobs only until they are able to perform them satisfactorily or at least are performing them correctly. Usually this takes the rest of their first day on the job. The second day they are instructed on the rest of the line operations, except the labeler, which is reserved for the third day. They are placed alternately on the line with the experienced operators on the second day, and rotate at half hour intervals for approximately three more days. The regular one hour rotation intervals are cut in half to eliminate fatigue and also speed up the time needed to complete one entire learning circuit of the line.

Each operator is instructed individually on each job and a definite routine is followed:

1. They are first shown how to do the job several times without any explanation, but asked to watch closely, making sure they can see what is being done.

2. It is then explained why it should be done this way, and the operation performed slowly as it is explained step by step.

3. They are then shown how and where the fingers and hands are used, and what each motion should accomplish. The key points are stressed and safe practice, accuracy, and inspection requirements are included.

4. When the relation and purpose of each step is understood the operation is done once again at production speed by the instructor.

5. The new operator then takes over the job and is asked to do it slowly at first and to concentrate on the correct sequence of motions, which will be restated again if necessary. A good work pattern must be established first. If it seems difficult for the operator to remember or understand what she is expected to do, she is asked to repeat the instructions or key points as she does the job. Although she is requested to do the job slowly at first the aim is still high; she must not be allowed to forget this. Pretty good just isn't good enough.

6. The new operator is watched closely at this point to note any mistakes or unnecessary motions, which are corrected before they become habits. It often helps if the reasons for a certain mistake can be pointed out and how to avoid it. This is especially true if there is any danger of injury either to the employee or the equipment.

On the last operation or semi-automatic labeler there are more factors to be considered in training a new operator than on most of the other line jobs. The safety of the operator is always the first consideration. The machine is slowed down for the first instruction period, or approximately one-half hour. This time varies because the machine is operated until the necessary rhythm has been acquired and the bottles are being placed on the conveyor two at a time. During this time the operator is observed closely to see that she does not become too fatigued or start losing the rhythm. We want them to stop when they have built up some confidence and before they start to worry. By doing this, they will be more relaxed at the start of the second session.

The first step as well as the last is explaining the goal, which is continuous operation of the labeler at standard production speed with acceptable labels. The purposes of all the working parts of the machine and safety devices are shown and explained as well as how and when they are used.

The operator is shown exactly how her fingers should be placed on the bottle, how it should be held and moved, both for her safety and for positioning in and removing from the label machine.

The timing is explained, as to how they should *listen* and *look* but not *watch* the labeler. There is a very definite tendency to be hypnotized by the machine if they watch it closely. If this happens they are quite apt to get excited and put their fingers in the machine. The instructor stays with them continuously during the first run.

When the new operators do all the jobs fairly well they are left pretty much on their own with an occasional check to be sure they are not unlearning what they have been taught. They are encouraged to ask any questions about the work that may puzzle them. Before they are left completely on their own, it is explained how the operations they have learned compare with those on other lines as to basic similarity and what they can expect from the standpoint of various bottle sizes and shapes, other types of packages and other equipment used. They are even cautioned concerning blisters on their fingers and what they should do about them.

A rather odd thing occurs in connection with these blisters. Although they are warned that they will get them, and they are largely due to holding larger bottles too tight, many girls seem surprised and almost pleased when they do get them. They will display them as though they were badges of merit.

One of the things that was found to be necessary was a complete description of each individual job. This was done before MTM was used in the Company, and what was thought to be a complete breakdown of the jobs when the training program was started did not prove to be so complete in actual practice. Of course, the jobs were gradually broken down as experience showed what was lacking. One example was that in almost every group of operators there would be one or more girls who would have trouble closing small cartons. They would consistently crumple the tuck-in flap. Actually, this was caused by the position of the index finger, or rather lack of positioning, on the flap. This trouble was mostly eliminated after it was noted in the job description.

The preparation of a "Training Manual for Instructors" is now in process and will contain an MTM breakdown of all the basic jobs.

Perhaps a criterion of how successful the training program has been is the fact that although this training has never been compulsory but strictly by request of the foremen, additional instructors are going to be required to supply this demand. Up to now, the Methods and Standards Department has supplied this service. Under our plans for the future, only the instructors will be trained by Methods and Standards and will be assigned permanently to the department in which they operate.

*ADDITIONAL TRAINING NOTES:*

The new employee is placed in a line with older employees. There is no loss in production the first two days for the new operator is placed on the type of job where the more experienced operators can and do help to carry the load. The instructor may also help the new employee. A loss in production for a crew will occur when the new employee operates the labeler. This is the most difficult job to learn. The loss for the crew with the new employee on the labeler amounts to approximately twenty per cent the first day. The crew would be up to standard production at the end of a week. The plant is not an incentive, but the performance pace of its employees is often better than a standard day work task.

The half-hour rotational period was used for it was found that the new operators were fatigued at the end of this period. This seemed to be about the right length of time to help to avoid mistakes. The lines would be shut down only two or three minutes during this change. If an operator had to leave the line, she would be replaced.

The normal training period for a new employee is one week. A foreman can ask for additional time if he feels that it is necessary. There have been a few cases where a whole department has been trained at one time. This occurs when a new carton is introduced or when there is a change in method as requested by the Standards and Methods Department.

The operators were required to know all the operations in a department. However, they would rotate only on the line on which they were working. There are approximately 10 different operations in the packing lines plus roving control inspectors. There is no pay range for the operations within the packaging operator classification. An operator could be promoted by transfer to another job in another department. The pay scale for the plant is as good as or better than the going rates for similar jobs in the community.

Approximately seventy people in two departments have been trained in the last year. There has been no training done in the Process Departments. This is because the turn-over is lower and there have been no requests for training from the foremen of those departments. The supervisory force has not been cut down because of the operator training. However, there has been an increase in over-all plant personnel without any increase in supervision.

There are no tests given to the prospective employees at the time of hiring to determine if they have the manual dexterity required by the job. However, the hobbies of the employees are investigated for it has been found, for example, that a woman interested in knitting will make a better operator. A laboratory set up for training new employees has been considered, but it was felt that it would take too much equipment.

MTM is going to be used to study the more difficult jobs and any jobs where the method may be in question. MTM as such or technical terms are not used in the training of the operators. The initial period is confusing enough without introducing all new terms. During this initial period the stress is placed on doing the job and not noticing the other people on the line.

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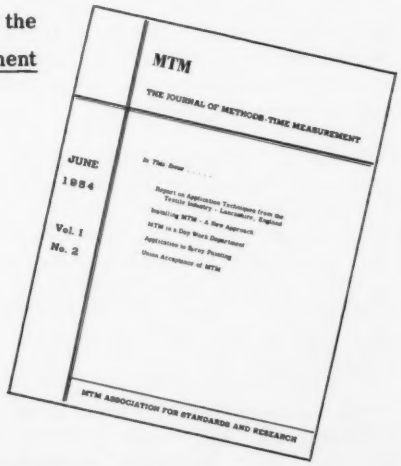

# APPLICATION

# II

## MTM STANDARD DATA FOR ASSEMBLY OPERATIONS

Norman Dean
Brammer Manufacturing Company
Davenport, Iowa

Our first introduction to MTM came in 1952. At that time four of us at Brammer received the Standard 105 hour course. Included in this foursome was the Personnel Manager and the Plant Superintendent. These two did not apply MTM directly, but indirectly they were a very important factor in the successful application of MTM in our plant.

Since our initial training, we have had appreciation training courses in our own plant for foremen, set-up men and even machine operators.

We have used MTM for developing better methods, to establish job standards for an incentive system, for product design and many other uses. Our standards are set by MTM Standard Data or by individual analyses. We use time study whenever necessary to cover conditions where MTM does not apply or where time study is more practical.

We used MTM for quite a while before we started developing Standard Data. Actually, we had Standard Data up to a certain point and didn't realize it. We recognized that on parts of similar construction but of different size, that many of the motions were constant with only a few motions varying in the motion pattern.

Finally, in our coverage of the milling section with methods and standards, we came upon an operation that couldn't be covered by any other practical way except by Standard Data. There were plywood ripping and cut-off operations where a sheet of plywood could be ripped once, twice, three times or as many times as was necessary.

After it was ripped, each strip ripped from that sheet could be cut up into several different sizes. There is a saying that "Necessity is the greatest inventor of all." This was certainly true in our case. After studying this operation for some time, we started developing data similar to the set that will be explained here today. We have made refinements since starting and I'm sure there is room for more improvements.

We have applied this form of Standard Data to operations that vary from 20.0 TMU to over 20,000 TMU per cycle. Basically, the forms are the same but some Standards are summarized in tables and some are applied by means of formulas.

The data were developed on hand assembly of a wooden kitchen cabinet using MTM. This operation involves the fastening of parts together on an assembly bench by means of hammer, nails, glue and staples. There is a lot of hammering involved. This was a little bit tricky to analyze at first. We found a lot of differences in analyses for driving the same size nail in different kinds of wood, in edge grain, in end grain and even the moisture content of the wood is a factor. The assembler is supplied with all material and supplies by a material handler.

In Exhibits 3 to 11 you will find a sample of each form or each step involved in developing this set of data.

The first form is the "Application" or the explanation of the set of data, Exhibit 3. On this sheet the workplace or station and operation are identified. Then the unit or type of part is identified and the ranges of size listed. In this particular set, the depth and height are constant and the widths of the units vary. Cabinets of this type of any width from 25" to 42" are covered by their data with standards.

Next there is a brief explanation of each element. The purpose of this is to give a quick review of the element in case of future reference to the set after a period of time has elapsed or for someone who is not familiar with the set of data.

On Exhibits 4 and 5 we really get down to the heart of the data. This is the analysis spread sheet where we combine analyses for several different ranges or sizes of parts into one analysis.

At the very top, there is the identifying information such as work station, operation, range, etc.

In the left hand column we have "Element and Description." In this column the element and number are recorded. Under the element, the motion description is recorded.

The next three columns are "Left", "Right", and "V or C." The Left and Right designate the hand used. The V indicates that a motion varies between one range and another. The C indicates the motion is constant for all ranges. Across the page, and "M" and a "T" are placed under each range. The M is the column the motion is recorded in, and the T is the column where the TMU is recorded.

As previously mentioned, on parts that are similar except for size, many of the motions are the same and only a few vary. Most of the variables used are the motions involved in getting to and from the part and in moving the part during the operation.

The first step in the analyses is to analyze one of the elements of a range on a Standard analysis sheet. This range should preferably be one of the middle ranges. After the analysis is made, it is then spread to this type of analysis sheet. It is easier to be consistent with this spread type of analysis, instead of making up a different analysis for each part or range. The constant motions are recorded under one range, with the variable motions, which usually can be visualized, being recorded under each range. There is no need to list each constant motion under each range.

The old MTM times are used throughout these data. Our new data have the revised times. At the time these data were developed we were using the old times.

The limiting motion is recognized throughout. If the limited out-motion is of importance for motion pattern description, it is shown in the conventional way. The "x" indicating the limiting motion, is placed across from the motion or motions in the element and description column. An example of this is shown on Exhibit 4 at the very beginning of element 11A, where the left hand is getting nails while the right hand is reaching to and picking up the hammer.

On the first line after the R-A reach to the nails, no motion is shown but a time of 66.2 TMU is recorded. This is a little short cut we have of developing a universal set of data, or data that are common to many different analyses. Getting 5d box nails from a nail apron is a very common thing in this department. Instead of analyzing it every time it occurs, we analyze it once and refer back to it from other sets of data. These universal type data are identified alphabetically instead of numerically. The S.D.-B-1 in the bracket indicates the 66.2 TMU is from Standard Data, Set B, page 1.

On an 11 or 12 minute cycle, there is a lot of TMU involved. It is easy to get either real long elements or a large bulky quantity of elements. Instead of having one real long element, the element can be broken down into sub-elements and analyzed. The particular element shown in this set is broken down into 3 sub-elements, 11 A, B and C.

After all of the elements are analyzed, the elements are summarized as shown in Exhibit 6. Each element and range is shown. A reference column is next, showing the set of data the element is from and the page. Frequently, a complete element is taken from the universal set of standard data. The TMU for each element and the allowance for P. F. D. is shown. After the allowance has been added, the occurrence factor is also applied.

A Standard Summary Sheet is used next as shown in Exhibits 7 and 8. Each element and range is shown with the TMU being listed under the proper range. This set of data has 38 elements, so it was necessary to carry over onto two pages.

The ranges are totaled giving a total TMU per range. A conversion factor is then applied to convert into Standard Hours. If a constant allowance is used, it could be added to the TMU here instead of on the summary shown in Exhibit 6. If an allowance of 15 per cent was used it could even be combined into the conversion factor, and the allowance and conversion to hours could be done in one calculation. This factor would be .0000115.

After the hours per cabinet is shown, the cabinets per hour and minutes per cabinet are listed.

This covers most of the data, but to make the data complete, any workplace sketches such as stock racks or workplace layouts are also in the data as shown in Exhibits 9 and 10.

Last is a complete set of instructions that are actually assembly instructions for the cabinet assembler. This is included for several reasons. One big reason is that any change in the data that would change the method of assembly is quickly spotted. This set of instructions will be placed in an assembler's manual which also contains sketches or workplace layout as shown in Exhibits 9 and 10.

This is the way we use standard data at Brammer Manufacturing Company. There are standards set on assembly operations and machining operations by this type of data, on incentive and non-incentive work. We have over 600 different standards set on one high production machine. Most of these standards are set by standard data.

There is always a better way of accomplishing a task in Industrial Engineering as well as a manual operation out in the shop. With this thought in mind, we are always looking for a better way of developing data.

*ADDITIONAL COMMENTS*

There are elements for the handling of tools that are constant throughout the plant. The motion pattern for driving a nail would remain the same although the number of strokes may vary. The variable in driving a nail would be whether the nail were to be driven into end grain or edge grain and the type of wood. A twelve

ounce hammer is used as standard. If an operator can drive a nail with one stroke, it is to his advantage for the standard is set on an average operator and allows for more than one stroke.

Before the MTM installation, standards had been set using average production. During the MTM installation, methods improvements were made that in many cases cut the standard in half. The operators make twenty or twenty-five per cent bonus on MTM standards in Milling Department. Foremen and key operators were trained during the original installation. There was no union when this original installation was made. Management desired a union because union carpenters gave some trouble when installing cabinets without a union label. One of the stewards was trained as an operator during the original installation and now helps management because he recognizes the standards.

The finished product does not change very much from year to year. However, a complete new line was added last year. There is a limited quality control program with better inspection being required since the installation of the incentive program. The operators are required to do a good job and are paid only for the good parts that they produce.

Whenever there is a change in the method of doing a job, there is a corresponding change in the standard. This is written into the contract with the union. A standard will be changed if there is a one per cent change in the time required to perform the operation. There is no method of financial compensation for the operator who improves on a method. There is, of course, verbal and written recognition.

There is little cross-filing of elements used in the plant. This is not much of a problem as the plant is small and there are only two men in the Methods and Standards Department. The jobs are constantly being checked to be sure that there are no creeping methods changes. A complete cycle of the standards is made as often as time permits. The ratio of women to men in the plant is changing with more women now being employed. Approximately sixty per cent of the employees are women. The foremen in the plant are not on incentive of any type.

EXHIBIT 3

STANDARD DATA

MACHINE: Assembly Line

OPERATION: Assemble

REFERENCE: Assembly Line, Set B and Set 2

APPLICATION: This set of data is for operation "Assemble" on regular double base units. It applies only to those cabinets with two doors and two drawers that fall in the following ranges:

| RANGE | DEPTH | WIDTH | HEIGHT |
|---|---|---|---|
| A | 23½" | 25" to 27" | 34½" |
| B | 23½" | 28" to 30" | 34½" |
| C | 23½" | 31" to 33" | 34½" |
| D | 23½" | 34" to 36" | 34½" |
| E | 23½" | 37" to 39" | 34½" |
| F | 23½" | 40" to 42" | 34½" |

The analyses in this data were analyzed on the double assembly bench on the west side of the conveyor. There are a few differences in motion pattern on the east side and west side of the conveyor, but mostly in the hand being used. These differences are insignificant and the standards are not affected.

EXPLANATION OF ELEMENTS

Element 1. Move 1 to 3 back panels from skid to post. This element is for moving from 1 to 3 back panels from the skid to the post or support behind the bench. The element begins after the previous cabinet is placed on the conveyor and ends when the panels are released.

WORK STATION: Assembly Line OPERATION: Assemble EXHIBIT: 4

MATERIAL: Double Base Unit DATE: March 24, 1955

| ELEMENT AND DESCRIPTION | LEFT | RIGHT | V or C | RANGE: A D- 23½" W- 25" to 27" H- 34½" | | RANGE: B D- 23½" W- 28" to 30" H- 34½" | | RANGE: C D- 23½" W- 31" to 33" H- 34½" | | RANGE: D D- 23½" W- 34" to 36" H- 34½" | | RANGE: E D- 23½" W- 37" to 39" H- 34½" | | RANGE: F D- 23½" W- 40" to 42" H- 34½" | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | M | T | M | T | M | T | M | T | M | T | M | T |
| 11. Faster L.H. End Frame | | | | | | | | | | | | | | | |
| 11A. Fasten front stile | | | | | | | | | | | | | | | |
| To apron pocket | x | | V | R11A | 9.2 | R14A | 10.5 | R17A | 11.9 | R20A | 13.1 | R23A | 14.5 | R26A | 15.8 |
| Get 6-8-5d nails(S.D.-B-1) | x | | C | | 66.2 | | | | | | | | | | |
| To hammer | | x | C | R B | .0 | | | | | | | | | | |
| Grasp handle | | x | C | G1A | .0 | | | | | | | | | | |
| Move nails up | x | | V | M11B | 12.8 | M14B | 14.6 | M17B | 16.4 | M20B | 18.2 | M23B | 20.0 | M26B | 21.8 |
| Regrasp nail | x | | C | G2x2 | 33.6 | | | | | | | | | | |
| Move to place | x | | C | M2C | 12.6 | | | | | | | | | | |
| Align | x | | C | P1SE | 16.8 | | | | | | | | | | |
| Raise hammer | | x | C | M2Bx2 | 25.2 | | | | | | | | | | |
| Tap nail | | x | C | M2Cx2 | 25.2 | | | | | | | | | | |
| Once per each horiz x3 frame: Move hammer out | | x | C | M8B | 31.8 | | | | | | | | | | |
| Tap fronts even | | x | C | M3C | 17.1 | | | | | | | | | | |
| Move hammer out | | x | C | M3B | 17.1 | | | | | | | | | | |
| Tap again | | x | C | M3C | 17.1 | | | | | | | | | | |
| Raise hammer | | x | C | M8B | 31.8 | | | | | | | | | | |
| Tap nail | | x | C | M3C | 17.1 | | | | | | | | | | |
| Raise hammer | | x | C | M4Bx3 | 67.1 | | | | | | | | | | |
| Hit nail | | x | C | M4Ax3 | 54.9 | | | | | | | | | | |
| To 2nd horizontal | x | | C | M6B | 8.9 | | | | | | | | | | |
| (Continued on next page) | | | | | 455.6 | | 458.7 | | 461.9 | | 464.9 | | 468.1 | | 471.2 |

ounce hammer is used as standard. If an operator can drive a nail with one stroke, it is to his advantage for the standard is set on an average operator and allows for more than one stroke.

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WORK STATION: Assembly Line OPERATION: Assemble EXHIBIT: 4

MATERIAL: Double Base Unit DATE: March 24, 1955

| ELEMENT AND DESCRIPTION | LEFT | RIGHT | V or C | RANGE: A D- 23½" W- 25" to 27" H- 34½" | | RANGE: B D- 23½" W- 28" to 30" H- 34½" | | RANGE: C D- 23½" W- 31" to 33" H- 34½" | | RANGE: D D- 23½" W- 34" to 36" H- 34½" | | RANGE: E D- 23½" W- 37" to 39" H- 34½" | | RANGE: F D- 23½" W- 40" to 42" H- 34½" | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | M | T | M | T | M | T | M | T | M | T | M | T |
| 11. Faster L.H. End Frame | | | | | | | | | | | | | | | |
| 11A. Fasten front stile | | | | | | | | | | | | | | | |
| To apron pocket | x | | V | R11A | 9.2 | R14A | 10.5 | R17A | 11.9 | R20A | 13.1 | R23A | 14.5 | R26A | 15.8 |
| Get 6-8-5d nails(S.D.-B-1) x | x | | C | | 66.2 | | | | | | | | | | |
| To hammer | | x | C | R B | .0 | | | | | | | | | | |
| Grasp handle | | x | C | G1A | .0 | | | | | | | | | | |
| Move nails up | x | | V | M11B | 12.8 | M14B | 14.6 | M17B | 16.4 | M20B | 18.2 | M23B | 20.0 | M26B | 21.8 |
| Regrasp nail | x | | C | G2x2 | 33.6 | | | | | | | | | | |
| Move to place | x | | C | M2C | 12.6 | | | | | | | | | | |
| Align | x | | C | P1SE | 16.8 | | | | | | | | | | |
| Raise hammer | | x | C | M2Bx2 | 25.2 | | | | | | | | | | |
| Tap nail | | x | C | M2Cx2 | 25.2 | | | | | | | | | | |
| Once per Move hammer out | | x | C | M8B | 31.8 | | | | | | | | | | |
| each Tap fronts even | | x | C | M3C | 17.1 | | | | | | | | | | |
| horiz x3 Move hammer out | | x | C | M3B | 17.1 | | | | | | | | | | |
| frame Tap again | | x | C | M3C | 17.1 | | | | | | | | | | |
| Raise hammer | | x | C | M8B | 31.8 | | | | | | | | | | |
| Tap nail | | x | C | M3C | 17.1 | | | | | | | | | | |
| Raise hammer | | x | C | M4Bx3 | 67.1 | | | | | | | | | | |
| Hit nail | | x | C | M4Ax3 | 54.9 | | | | | | | | | | |
| To 2nd horizontal | x | | C | M6B | 8.9 | | | | | | | | | | |
| (Continued on next page) | | | | | 455.6 | | 458.7 | | 461.9 | | 464.9 | | 468.1 | | 471.2 |

EXHIBIT 4

WORK STATION: Assembly Line OPERATION: Assemble EXHIBIT: 5

MATERIAL: Double Base Unit DATE: March 24, 1955 SET: 4 PAGE: 34

| ELEMENT AND DESCRIPTION | L E F T | R I G H T | V o r C | RANGE: A D- 23½" W- 25" to 27" H- 34½" | | RANGE: B D- 23½" W- 28" to 30" H- 34½" | | RANGE: C D- 23½" W- 31" to 33" H- 34½" | | RANGE: D D- 23½" W- 34" to 36" H- 34½" | | RANGE: E D- 23½" W- 37" to 39" H- 34½" | | RANGE: F D- 23½" W- 40" to 42" H- 34½" | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | M | T | M | T | M | T | M | T | M | T | M | T |
| Element 11 continued (11A) | | | | | 455.6 | | 458.7 | | 461.9 | | 464.9 | | 468.1 | | 471.2 |
| Step to left | x | | C | SS1201 | 17.0 | | | | | | | | | | |
| Move to 3rd horizontal | x | | C | mM12B | 10.0 | | | | | | | | | | |
| TOTAL | | | | | 482.6 | | 485.7 | | 488.9 | | 491.9 | | 495.1 | | 498.2 |
| 11B. Fasten 3rd & 2nd horizontal | | | | | | | | | | | | | | | |
| To nail location | x | | C | M4B | 27.6 | | | | | | | | | | |
| Once Regrasp | x | | C | G2x2 | 44.8 | | | | | | | | | | |
| per x4 Move to place | x | | C | M2C | 16.8 | | | | | | | | | | |
| location Align | x | | C | P1SE | 22.4 | | | | | | | | | | |
| Drive 5-d nail-rail(S.D.-B-6) x3 | | x | C | 86.4 | 259.2 | | | | | | | | | | |
| Drive 5-d nail-stile(S.D.-B-17) | | x | C | | 60.4 | | | | | | | | | | |
| To nails | x | | V | R21A | 13.6 | R24A | 14.9 | R27A | 16.3 | R30A | 17.5 | R33A | 18.7 | R36A | 19.9 |
| Get 6-8 5d nails(S.D.-B-1) x | x | | C | | 66.2 | | | | | | | | | | |
| Step to right | | x | C | SS1801 | .0 | | | | | | | | | | |
| Nails to area | x | | V | M11B | 12.8 | M14B | 14.6 | M17B | 16.4 | M30B | 18.2 | M23B | 20.0 | M26B | 21.8 |
| Once Regrasp nails | x | | C | G2x2 | 44.8 | | | | | | | | | | |
| per x4 Move to place | x | | C | M2C | 16.8 | | | | | | | | | | |
| Location Align | x | | C | P1SE | 22.4 | | | | | | | | | | |
| Drive 5d nail-rail(S.D.B-16)x3 | | x | C | 86.4 | 259.2 | | | | | | | | | | |
| Drive 5d nail-stile(S.D.-B-17) | | x | C | | 60.4 | | | | | | | | | | |
| To location #3-4-5 x3 | x | | C | M4B | 27.6 | | | | | | | | | | |
| TOTAL | | | | | 955.0 | | 958.1 | | 961.3 | | 964.3 | | 967.3 | | 970.1 |

EXHIBIT 5

MACHINE: Assembly Line
OPERATION: Assemble
MATERIAL: Double Base Unit

EXHIBIT: 6
SET: 4
PAGE: 124
DATE: March 24, 1955

SUMMARY OF MTM ANALYSIS

Prepared by: Norman M. Dean

| ELEMENT & DESCRIPTION | Reference Set | Reference Page | TMU | % Allow. | Time & Allow. | Occur. Per Cycle | Total TMU |
|---|---|---|---|---|---|---|---|
| 1. Move 1 to 3 back panels from skid to post. | | | | | | | |
| Ranges: A-25" to 27" | 4 | 11 | 291.7 | 15 | 335.5 | 1.00 | 335.5 |
| B-28" to 30" | 4 | 11 | 292.3 | 15 | 336.1 | .33 | 110.9 |
| C-31" to 33" | 4 | 11 | 294.2 | 15 | 338.3 | .50 | 169.2 |
| D-34" to 36" | 4 | 11 | 294.1 | 15 | 338.2 | .33 | 111.6 |
| E-37" to 39" | 4 | 11 | 295.3 | 15 | 339.6 | 1.00 | 339.6 |
| F-40" to 42" | 4 | 12 | 296.0 | 15 | 340.4 | 1.00 | 340.4 |
| 2. Place 1 to 3 horizontal frames on bench. | | | | | | | |
| Ranges: A-25" to 27" | 4 | 13 | 171.2 | 15 | 196.9 | 1.00 | 196.9 |
| B-28" to 30" | 4 | 13 | 172.1 | 15 | 197.9 | .33 | 65.3 |
| C-31" to 33" | 4 | 13 | 172.1 | 15 | 197.9 | .50 | 99.0 |
| D-34" to 36" | 4 | 13 | 173.0 | 15 | 199.0 | .33 | 65.7 |
| E-37" to 39" | 4 | 13 | 173.7 | 15 | 199.8 | 1.00 | 199.8 |
| F-40" to 42" | 4 | 14 | 174.3 | 15 | 200.4 | 1.00 | 200.4 |
| 3. Get 3 dividers from rack. | | | | | | | |
| Ranges: A-25" to 27" | 4 | 15 | 142.4 | 15 | 163.8 | 1.00 | 163.8 |
| B-28" to 30" | 4 | 15 | 143.1 | 15 | 164.6 | .33 | 54.3 |
| C-31" to 33" | 4 | 15 | 143.8 | 15 | 165.4 | .50 | 82.7 |
| D-34" to 36" | 4 | 15 | 145.2 | 15 | 167.0 | .33 | 55.1 |
| E-37" to 39" | 4 | 15 | 146.5 | 15 | 168.5 | 1.00 | 168.5 |
| F-40" to 42" | 4 | 16 | 147.1 | 15 | 169.2 | 1.00 | 169.2 |
| 4. Place spacer on frame. | | | | | | | |
| Ranges: A-25" to 27" | 4 | 17 | 85.8 | 15 | 98.7 | 1.00 | 98.7 |
| B-28" to 30" | 4 | 17 | 85.8 | 15 | 98.7 | .33 | 32.6 |
| C-31" to 33" | 4 | 17 | 85.8 | 15 | 98.7 | .50 | 49.4 |
| D-34" to 36" | 4 | 17 | 85.8 | 15 | 98.7 | .33 | 32.6 |
| E-37" to 39" | 4 | 17 | 85.8 | 15 | 98.7 | 1.00 | 98.7 |
| F-40" to 42" | 4 | 17 | 85.8 | 15 | 98.7 | 1.00 | 98.7 |

EXHIBIT: 7
SET: 4
PAGE: 132
DATE: March 24, 1955

OPERATION: Assemble
MATERIAL: Double Base Units

## STANDARD SUMMARY SHEET

| ELEMENTS | RANGE | A | B | C | D | E | F |
|---|---|---|---|---|---|---|---|
| | DEPTH: | 23½" | 23½" | 23½" | 23½" | 23½" | 23½" |
| | WIDTH: | 25" to 27" | 28" to 30" | 31" to 33" | 34" to 36" | 37" to 39" | 40" to 42" |
| | HEIGHT: | 34½" | 34½" | 34½" | 34½" | 34½" | 34½" |
| Element 1. Move 1 to 3 back panels from skid to post. | | 335.5 | 110.9 | 169.2 | 111.6 | 339.6 | 340.4 |
| Element 2. Place 1 to 3 horizontal frames on bench. | | 196.9 | 65.3 | 99.0 | 65.7 | 199.8 | 200.4 |
| Element 3. Get 3 dividers from rack. | | 163.8 | 54.3 | 82.7 | 55.1 | 168.5 | 169.2 |
| Element 4. Place spacer on frame. | | 98.7 | 32.6 | 49.4 | 32.6 | 98.7 | 98.7 |
| Element 5. Fasten drawer divider. | | 563.2 | 566.5 | 568.0 | 571.2 | 574.4 | 576.0 |
| Element 6. Move horizontal frame from bench to floor. | | .0 | 88.2 | 66.5 | 89.5 | .0 | .0 |
| Element 7. Move spacer aside and place 2nd horiz. frame. | | 192.3 | 64.9 | 100.5 | 68.0 | 210.5 | 214.7 |
| Element 8. Get 2nd horizontal from floor and place. | | .0 | 126.8 | 94.1 | 123.6 | .0 | .0 |
| Element 9. Get 2 more horizontal frames and place. | | 328.8 | 329.8 | 329.8 | 330.9 | 331.7 | 332.4 |
| Element 10. Get L.H. end frame and place. | | 290.0 | 290.0 | 290.0 | 290.0 | 290.0 | 290.0 |
| Element 11. Fasten L.H. end frame. | | 2294.1 | 2305.5 | 2320.1 | 2334.0 | 2348.3 | 2362.4 |
| Element 12. Turn right end of cabinet up. | | 102.1 | 104.8 | 107.6 | 125.7 | 132.6 | 138.6 |
| Element 13. Get R.H. end frame and place. | | 285.0 | 285.0 | 285.0 | 285.0 | 285.0 | 285.0 |
| Element 14. Fasten R.H. end frame. | | 2388.4 | 2402.4 | 2416.8 | 2470.2 | 2487.3 | 2500.8 |
| Element 15. Turn cabinet over onto front. | | 179.6 | 186.5 | 193.7 | 200.7 | 207.8 | 215.2 |
| Element 16. Place back panel. | | 243.5 | 243.5 | 243.6 | 242.1 | 240.5 | 240.6 |
| Element 17. Fasten back panel. | | 1385.9 | 1395.8 | 1548.1 | 1559.4 | 1707.2 | 1723.2 |
| Element 18. Turn cabinet upright. | | 112.7 | 112.7 | 112.7 | 112.7 | 112.7 | 112.7 |
| Element 19. Place cupboard bottom. | | 202.2 | 201.1 | 200.0 | 199.1 | 201.3 | 203.6 |
| Element 20. Fasten cupboard bottom. | | 573.0 | 575.9 | 643.7 | 639.5 | 696.6 | 703.1 |
| Element 21. Place thumbtacks. | | 748.8 | 748.8 | 750.0 | 750.0 | 751.4 | 751.4 |
| Element 22. Place shelf supports. | | 341.6 | 344.2 | 347.5 | 350.9 | 352.4 | 357.4 |
| Element 23. Place shelf. | | 215.9 | 220.2 | 224.6 | 229.1 | 233.5 | 237.9 |
| (Continued on next page) | | 11242.0 | 10855.7 | 11242.6 | 11236.6 | 11969.8 | 12053.7 |

EXHIBIT 7

EXHIBIT: 8
SET: 4
PAGE: 133
DATE: March 24, 1955

## STANDARD SUMMARY SHEET

OPERATION: Assemble
MATERIAL: Double Base Units

| ELEMENTS | RANGE | A | B | C | D | E | F |
|---|---|---|---|---|---|---|---|
| | DEPTH: | 23½" | 23½" | 23½" | 23½" | 23½" | 23½" |
| | WIDTH: | 25" to 27" | 28" to 30" | 31" to 33" | 34" to 36" | 37" to 39" | 40" to 42" |
| | HEIGHT: | 34½" | 34½" | 34½" | 34½" | 34½" | 34½" |
| (Continued from previous page) | | 11242.0 | 10855.7 | 11242.6 | 11236.6 | 11969.8 | 12053.7 |
| Element 24. Fasten shelf blocks in. | | 767.3 | 769.1 | 771.0 | 790.1 | 791.9 | 794.7 |
| Element 25. Get center stile and place. | | 225.6 | 225.6 | 225.6 | 225.6 | 225.6 | 225.6 |
| Element 26. Fasten center stile. | | 2400.7 | 2417.3 | 2427.9 | 2441.9 | 2455.3 | 2469.7 |
| Element 27. Get toeboard and place. | | 372.7 | 375.7 | 378.8 | 381.7 | 385.1 | 388.5 |
| Element 28. Fasten toeboard. | | 813.9 | 818.2 | 822.3 | 826.4 | 831.2 | 834.9 |
| Element 29. Set nails on toeboard. | | 338.1 | 342.1 | 345.1 | 348.2 | 352.1 | 354.9 |
| Element 30. Fill cabinet. | | 1352.9 | 1354.5 | 1360.3 | 1361.8 | 1365.4 | 1368.0 |
| Element 31. Sand 5d holes on front stile. | | 241.6 | 242.8 | 244.5 | 245.5 | 247.3 | 248.3 |
| Element 32. Place glue blocks. | | 578.5 | 591.3 | 603.1 | 614.8 | 626.3 | 637.7 |
| Element 33. Move cabinet to conveyor. | | 428.7 | 433.3 | 438.2 | 443.9 | 447.6 | 452.3 |
| Element 34. Load Senco Stapler (approximately 120). | | 67.8 | 67.8 | 75.4 | 75.4 | 82.9 | 82.9 |
| Element 35. Load Spotnail Stapler (approximately 134) | | 94.7 | 94.7 | 106.5 | 106.5 | 118.4 | 118.4 |
| Element 36. Fill box with glue blocks. | | 60.1 | 60.1 | 60.1 | 60.1 | 60.1 | 60.1 |
| Element 37. Fill apron with 5 penny box nails (approx. 200). | | 66.8 | 66.8 | 66.8 | 66.8 | 66.8 | 66.8 |
| Element 38. Fill apron with 4 penny finish nails (approx. 264). | | 8.7 | 8.7 | 8.7 | 8.7 | 8.7 | 8.7 |
| TOTAL TMU PER CABINET: | | 19060.1 | 18723.7 | 19176.9 | 19234.0 | 20034.5 | 20165.2 |
| CONVERSION FACTOR: | | .00001 | .00001 | .00001 | .00001 | .00001 | .00001 |
| HOURS PER CABINET: | | .19060 | .18724 | .19177 | .19234 | .20035 | .20165 |
| CABINETS PER HOUR: | | 5.25 | 5.34 | 5.21 | 5.20 | 4.99 | 4.96 |
| MINUTES PER CABINET: | | 11.44 | 11.23 | 11.51 | 11.54 | 12.02 | 12.10 |

EXHIBIT 9

SET: 4
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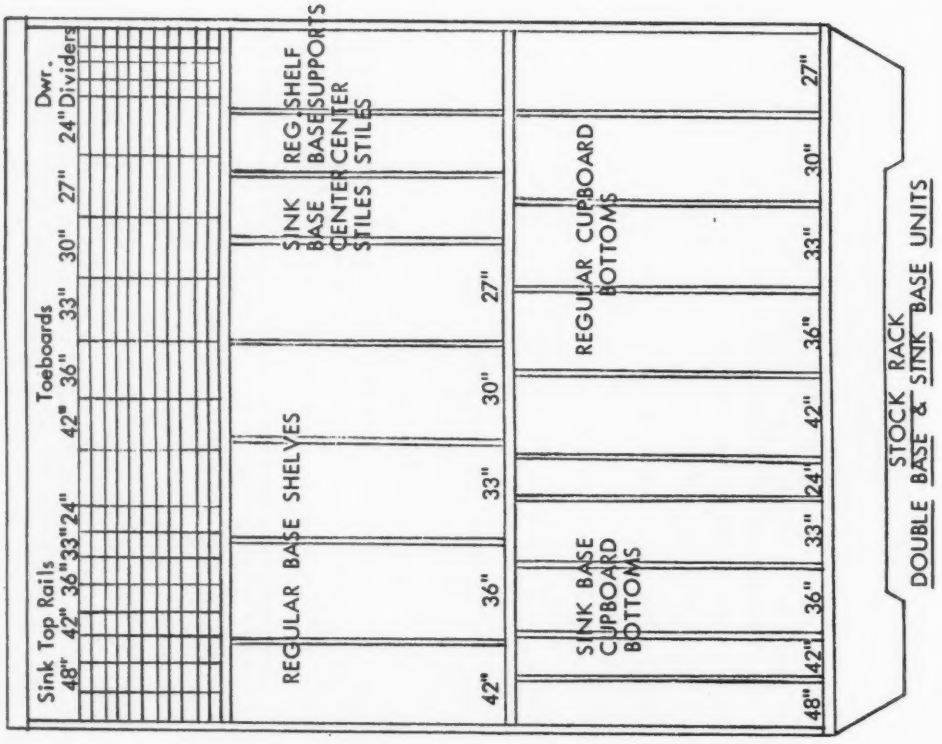
Sink Top Rails
48" 42" 36" 33" 24"
Toeboards
42" 36" 33" 30" 27" 24" Dwr. Dividers
REGULAR BASE SHELVES
42" 36" 33" 30" 27"
SINK BASE CENTER STILES
REG. SHELF BASE SUPPORTS CENTER STILES
SINK BASE CUPBOARD BOTTOMS
48" 42" 36" 33" 24"
REGULAR CUPBOARD BOTTOMS
42" 36" 33" 30" 27"
STOCK RACK
DOUBLE BASE & SINK BASE UNITS

EXHIBIT 10
SET: 4
PAGE: 135
DATE: March 24, 1955

LAYOUT SKETCH - DOUBLE BASE & SINK BASE UNITS

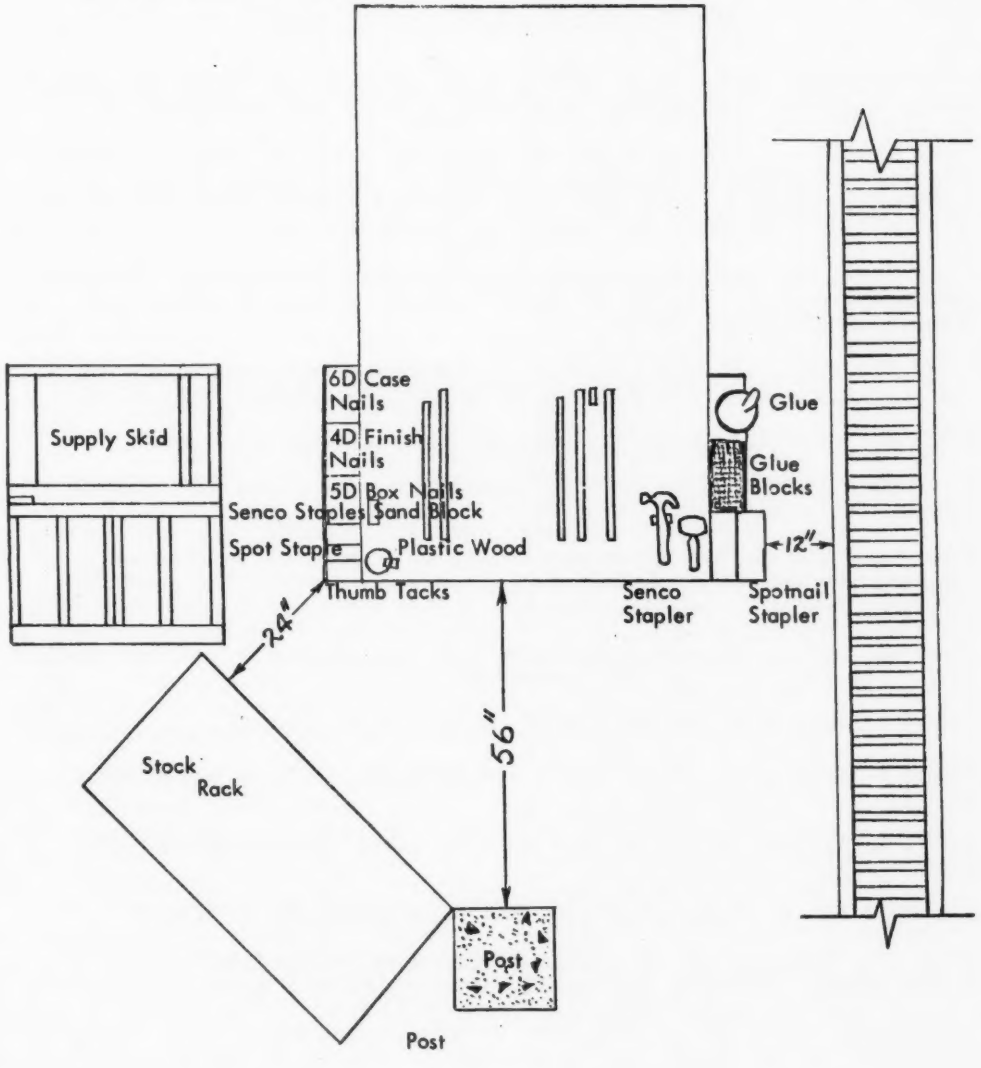

EXHIBIT 11
SET: 4
PAGE: 136
DATE: March 24, 1955

ASSEMBLY INSTRUCTIONS

DOUBLE BASE UNITS 25" to 42" WIDE

The work station for double base units is the first assembly bench south of Back Sander on either side of the conveyor.

For the layout of tools and supplies, see the layout sketches. The only difference in layout between the east side and west side of the conveyor is that the stock rack and conveyor are the reverse. Everything else about the layout is the same.

These instructions are for right handed Assemblers. For left handed Assemblers, a few adjustments will have to be made, such as reversing the hands used.

The Assembler shall wear a nail apron with 5 penny box nails in the left pocket and 4 penny finish nails in the right pocket.

All material is to be supplied by a material handler.

This operation is called "Assemble." The steps of assembly are as follows:

Move back panels for first run of cabinets from skid to floor, leaning the panels against the post or support with the good side out.

Move all 2nd horizontal frames for 1st run from skid to bench with the front stile facing the Assembler.

Get dividers from rack and place on left end of bench.

Reach to spacer at end of bench and move to place on top frame of pile.

Reach to divider with L.H. and move to place against spacer with both hands.

Get 2-4d finish nails with L.H. and pick up hammer with R.H.

Drive the 2 nails through divider into horizontal frame. Move hammer aside with R.H. and raise spacer up with L.H.

# APPLICATION

# III

## MTM STANDARDS FOR PICKING, CHECKING AND PACKING PATTERNS

Joseph Ruppe
Simplicity Pattern Co., Inc.
Niles, Michigan

Simplicity Pattern Co., Inc., manufactures paper patterns used in the making of garments. A pattern consists of tissue paper templates for a garment, an instruction sheet showing how to make the garment and an envelope.

Before the Company started the MTM incentive installation for picking, checking and packing we had successfully installed an MTM incentive plan for assembling the patterns. The Assembly Department, prior to the MTM installation, had a piece work payment plan made up of:

1. A rate per 1,000 for each of the tissue pieces in the pattern (there could be from 1 to 30 pieces in the pattern).

2. A rate for each attended hour.

3. A bonus for achieving a production quota for the week.

This method of payment was a source of constant trouble. An oddity in the situation was, that the employees were satisfied with the average total earnings. They were extremely reluctant to change the system of payment, but they wanted some way to equalize daily earning opportunities under the system.

An attempt was made to use Time Study to resolve some of the grievances. Studies of the patterns grieved about were made and compared with what was supposed to be "normal" pattern assemblies. The venture only made for further confusion, but eventually led to a way out of the dilemma. When the employees presented grievances over the accuracy and completeness of the time studies, they were given the privilege of selecting an outside firm to check the time studies. The Union Officials selected A. T. Kearney & Company, and the Union President made the initial contacts to secure the services of that company. Mr. Al Walter came to the plant at Niles and shortly after recommended that the piece rate payment system be abandoned and that new rates be established by using MTM.

Eventually, a supplement to the contract between the Company and the Union was agreed upon which provided that new Standards for assembling patterns would be set using MTM and that these new rates would be used for at least two years. It was further agreed that the amount of money earned during a previous 26 week period would be used to determine the base rate for the new standards so that the earnings under the two methods of payment would be the same.

MTM rates for this assembly operation were installed two years ago and the results have been very satisfactory.

The patterns manufactured by the Simplicity Pattern Co. are sold by 17,000 stores throughout the country. These stores are shipped a series or issue of patterns consisting of approximately 40 new styles each month. Each of the stores maintains a stock of patterns. The size of stock depends on the amount of business done by the store. It may be from 1,500 to 6,000 patterns. When a sale is made from this stock, the pattern number and size are posted to an order blank. At the end of the day these order blanks are mailed to the Simplicity Pattern Co. branch nearest the store. A large store may have filled in more than one blank during the day and would send them in. A small store may have only a few entries on the blank and might send in an order once or twice a week, although they are encouraged to send orders in daily.

These orders are processed by the Reorder Branch. The orders are picked, checked and packed for shipment to the customer.

There was an unsatisfactory situation in this department, too. The Supervisor maintained a weekly record of the number of patterns picked and checked and used this to try and maintain a satisfactory level of production from the workers. It was constantly necessary to criticize the poor producer and it was difficult to keep the good producers at a high level. In addition, we had the dissatisfaction aroused by comparison of earnings with those on incentives in the Assembly Department. Over a period of time, the production had fallen toward the level of the poor producers. Finally, we had a request by the Union that we place a minimum requirement per hour on the jobs. In fact, they suggested what the figures per hour should be. So again, we reached an agreement to put in the incentive plan using MTM and contracted to use the rates for two years, with the base rate to remain the same.

The first of the jobs tackled was the picking of the reorders. The orders are picked from bin sections which are back to back in rows 40 feet long.

There are 288 openings on each side of the rows and 8 rows for a total of 4,600 openings.

A major problem encountered with the setting of standards for the picking of the orders was that the orders did not all come in with the items in sequence. Some orders would be listed in exact sequence, others would be thoroughly mixed, and some were mixed but under the proper headings.

The orders were classified as:

Post Cards - In Order
- Out of Order

Sheet Orders - In Order
- In Partial Order
- Out of Order

The second job placed on standards was the *Checking*. Prior to the MTM installation, we had 100 per cent inspection. The checker matched the patterns picked with the order, item for item and corrected any mistakes. An analysis was made of the effectiveness of this inspection. We found that in spite of the inspection, one-half of one per cent of the patterns were going out wrong. This meant that with shipments of 200,000 patterns a week, 1,000 were wrong style or size in spite of 100 per cent inspection.

Another portion of this checking job was the pricing of the patterns. Bars are placed on the side of the pattern envelope to designate the price. After the patterns were checked, they were counted by price and the quantities posted to the order for billing purposes. Before the standards were set up, item by item, inspection was eliminated. A separate job of Inspector was created. The inspection takes a sampling of the orders picked, inspects them for errors found to a daily record. One inspector is able to cover 7 to 8 per cent of the order. The pickers and checkers are given a weekly summary of the result of the inspection of their work and the department average. The number of checkers has been cut from 8 to 4 by this change.

The next job on which standards were set was the picking of inventory books. Every four months we discard about 20 per cent of the patterns in the line. The stores are sent inventory books; they are asked to discard certain patterns and to post a count of the remainder of their stock. When the books are returned by the stores, the patterns that are missing are marked. A picker then picks these missing patterns for shipment to the customer.

The MTM analysis for picking patterns for the inventory books differed from the Reorder Picking in that the picking was in order, and it was necessary to go through the books.

The checking of the Inventory books followed. The major difference in this type of checking was in the size of the orders which required a greater number of cartons. Where the size of the order is over 100 patterns, the checker packs the patterns in a carton.

One of the problems that arose was in the recording of production. Orders are picked, checked, wrapped and billed as rapidly as possible. They could not be held up very long at any point. We finally placed a recording station after each of the checking stations. The pickers bring their orders to an assigned checking table. When the order has been checked it is posted by a clerk to a production sheet for the picker. This same sheet can then be used for the checkers count.

Some typical motion patterns are shown in Exhibits 18 and 19.

*ADDITIONAL COMMENTS*

The incentive program increased the production in the Assembly Department from 1,000 to 1,300 patterns per day. The union had wanted a rate on order picking set at 180 patterns per hour, the MTM Standard was set at 250 patterns per hour, and the employees are now producing over 300 patterns per hour. Some operators perform as high as 145 per cent against MTM Standards on order picking and a few exceptional operators in the Assembly Department perform at 200 per cent of the MTM Standard. They can do this because they change case "C" moves followed by positions to case "A" moves. Their super skills permit them to take short cuts in the method. The average operator required about two months of practice to meet the standard. All standards are set in standard hours per hundred patterns.

One of the first major methods changes that was made was to clean the checkers work tables. Checkers were working around pencils, purses, and miscellaneous materials, that could be put on a shelf under the table. The packing tables were cut to fourteen inches wide with a conveyor section from the original width of four feet. The cartons are now packed right on the conveyor section. This and other methods improvements were made and justified using MTM. Mechanical counting or pre-sorting by key punch was tried to help the order pickers in their operation. It was found that such methods would not be economical. A good operator can pick an order in sequence although the numbers may not be in order. Operators work at a performance as high as 145 per cent on an out-of-order list. The operators do not check off number as they pick it and there is some back tracking.

The original study in order picking was started on a good operator but several others were also

studied. The same order was processed several different ways to get an average performance. The union realized that the company must have performance but insisted that the old employee be protected. The old employee must perform at 82-1/2 per cent of the standard while the new employee must produce 100 per cent of standard within ninety days. An eight hour production study was taken when the application seemed to lag. An employee who had produced a consistent 70 per cent performed at 106 per cent while an employee who was just making the standard performed at 120 per cent during the study. The job classification of this area of order picking had been much undergraded. Because of the study, the job classification was raised.

The time allowed for reading and remembering a four digit number was set at two eye focus. Many operators could read four digits with one eye focus. The time for a two digit number was set at one eye focus. These times were checked by experimentation and stop watch. The counting is done in units of two plus three equal to five. The counting and billing standards will be verified in a month after their application.

EXHIBIT 18

MTM ELEMENT ANALYSIS

File

Part Name Patterns Part No.
Oper. Name Count and Record. Oper. No.
Operator No. Analyst Date 11-9-55

| DESCRIPTION - LEFT HAND | F | MOTION | TMU | MOTION | F | DESCRIPTION - RIGHT HAND |
|---|---|---|---|---|---|---|
| Count by 5's | | | | | | |
| | | | 5.9 | R2D | | Thumb To 3 |
| | | | 5.6 | P1SE | | |
| | | | 4.6 | M2B | | Move 3 Back |
| | | | 9.4 | R5D | | Index Finger to 2 |
| | | | 5.6 | P1SE | | |
| | | | 6.9 | M4B | | Separate 5 |
| | | | 5.6 | G2 | | Fingers Between for Next 5 |
| | | | - | ~~T45S~~ | | Turn Hand to Next 5 |
| Total Per 5 Patterns | | | 43.6 | | | |
| Per 1 Pattern | | | 8.7 | | | |
| Record Count of Patterns | | | | | | |
| (a) Less Than 10 | | | 15.8 | R16B | | To Pencil |
| | | | 2.0 | G1A | | |
| | | | 12.2 | M10B | | To Order |
| | | | - | ~~G2~~ | | |
| | | | 9.5 | P1SE | 1.7 | Record Count (1 No) |
| | | | 8.0 | MfB | 4.0 | |
| | | | 4.6 | M2B | | Raise Pencil |
| | | | 52.1 | | | |
| (b) 10 to 50 | | | 21.5 | R24B | | |
| | | | 2.0 | G1A | | |
| | | | 12.2 | M10B | | To Order |
| | | | - | ~~G2~~ | | |
| | | | 19.0 | P1SE | 3.4 | Record Count (2 No's) |
| | | | 16.0 | MfB | 8.0 | |
| | | | 4.6 | M2B | | Raise Pencil |
| | | | 75.3 | | | |
| (c) 50 to 100 | | | 20.6 | SS18C1 | | |
| | | | 14.4 | R14B | | To Pencil |
| | | | 2.0 | G1A | | |
| | | | 12.2 | M10B | | To Order |
| | | | - | G2 | | |
| | | | 19.0 | P1SE | 3.4 | Record Count (2 No's) |
| | | | 16.0 | MfB | 8.0 | |
| | | | 4.6 | M2B | | Raise Pencil |
| | | | 88.8 | | | |
| (d) Over 100 to 200 | | | 18.6 | TBC1 | | |
| | | | 30.0 | W2P | | |
| | | | 14.4 | R14B | | To Pencil |
| | | | 2.0 | G1A | | |
| | | | 12.2 | M10B | | To Order |
| | | | - | ~~G2~~ | | |
| | | | 28.6 | P1SE | 5.1 | Record Count (3 No's) |
| | | | 24.0 | MfB | 12.0 | |
| | | | 4.6 | M2B | | |
| | | | 134.4 | | | |

Sheet ____ Of ____

EXHIBIT 19 - 50

MTM ELEMENT ANALYSIS

File

Part Name Patterns Part No.
Oper. Name Initial Order, Fold and Assemble Oper. No.
Operator No. Analyst Date 11-9-55

| DESCRIPTION - LEFT HAND | F | MOTION | TMU | MOTION | F | DESCRIPTION - RIGHT HAND |
|---|---|---|---|---|---|---|
| Initial Order and Lay Aside Pencil | | | | | | |
| | | | 5.7 | M3B | | To Order |
| | | | 26.9 | P1SE | 4.8 | Write 2 Initials |
| | | | 19.2 | Mf3 | 9.6 | |
| | | | 12.2 | M10B | | Pencil Aside |
| | | | - | ~~G2~~ | | |
| | | | 2.0 | RL1 | | |
| | | | 66.0 | | | |
| Fold Order and Assemble with Patterns | | | | | | |
| (a) Small Sheet to Side of Sheet | | R4B | 6.4 | | | |
| | | G1B | 3.5 | | | |
| Fold Sheet and Pick Up | | M4B | 6.9 | | | |
| | | T90S | - | | | |
| | | | 6.4 | R4B | | To Sheet |
| To Right Hand | | G3 | 5.6 | G3 | | From Left Hand |
| | | | 12.2 | M10B | | To Front of Patterns |
| | | | 5.6 | G2 | | |
| | | | 2.0 | RL1 | | |
| | | | 48.6 | | | |
| (b) Large Sheet to Corner of Sheet | | R8B | 10.1 | | | |
| | | G1B | 3.5 | | | |
| | | G2 | 5.6 | | | |
| Raise Sheet | | M8B | 10.6 | R6B | | To Edge of Sheet |
| | | | 3.5 | G1B | | |
| | | | 11.2 | G2 | 2 | |
| | | | 8.9 | M6B | | Fold Sheet in Half |
| | | | - | ~~T90S~~ | | |
| | | | 11.2 | G2 | 2 | |
| | | | 5.7 | M3B | | Fold Sheet in 1/4 |
| | | | - | ~~T90S~~ | | |
| | | | 11.2 | G2 | 2 | |
| | | G3 | 5.6 | G3 | | |
| | | | 12.2 | M10B | | To Front of Patterns |
| | | | 5.6 | G2 | | |
| | | | 2.0 | RL1 | | |
| | | | 106.9 | | | |

Sheet ____ Of ____

# MTM NEWS

## H. B. MAYNARD RECEIVES DOCTOR OF LAWS

On February 6, 1956, H. B. Maynard, President of Methods Engineering Council, and past-president of the MTM Association received the degree Doctor of Laws from the University of Miami, Miami, Florida.

Mr. Maynard gave the commencement address at the University's mid-winter class graduation on the subject "Ten Years From Now."

MTM came in for recognition too. The citation preceding his award read as follows:

"Harold Bright Maynard, distinguished international authority in management, has applied with ingenuity and understanding, the process of management science for a broad range of human affairs. Because his methods-time measurement devices and methods engineering concepts have contributed greatly to the aims of American business for improvement of the standards of managing of the people of the world through economic production of goods and services, and because of his leadership in his profession, the University of Miami presents Harold Bright Maynard for the degree of Doctor of Law."

Congratulations, Dr. Maynard.

* * * * * *

## SVENSKA MTM FORENINGEN
### Swedish MTM Association Established December 28, 1955, Stockholm, Sweden

Lars Erik Fahlin, recently appointed Executive Secretary, informs that the Swedish Chapter has established a Board of Directors with Per Soderstrom as Chairman of the Board. Mr. Soderstrom is President of Volvo Pentaverken in Sweden.

Other members of newly elected Directorate of Svenska MTM are:

Gunnar Aste, president, Forsvarets Fabriksverk, Stockholm
Bengt Darnfors, plant manager, Volvo Co., Gothenburg
Sven Erik Erikson, vice-president, ASEA Co., Vasteras
Gosta Luthman, president, Marma-Langror Co., Soderhamn
Arne Korling, plant manager, Junex Co., Huskvarna
Holger Bohlin, vice-president, Ekonomisk Foretagsledning Co., Stockholm

We extend welcome and best wishes to Svenska MTM Foreningen.

* * * * * *

## HUDSON VALLEY SAM CHAPTER HOLDS MTM CONFERENCE

The Hudson Valley Chapter of Society For Advancement of Management will conduct a MTM Conference in Troy, New York, Wednesday, March 28, 1956.

A full explanation of "What is MTM?" and "How it Works," will be given. It is planned to present practical applications of MTM in Textiles, Assembly, Machining, and in Paper Making.

The program is expected to point the way to companies in the Hudson Valley area interested in predetermined time and standard data systems.

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## NEXT MTM ASSOCIATION BOARD MEETING

The MTM Association Board of Directors will meet Tuesday March 27, 1956 at the Engineers Club, New York City to consider current business.

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## JANUARY MEETING
## MTM ASSOCIATION OF SOUTHERN CALIFORNIA

Members of the MTM Chapter met January 11, 1956 for an interesting program of MTM applications. Lloyd Gilbert, Virtue Brothers Manufacturing Company, discussed the always difficult problem of packaging bulky products. His subject "Pack and Ship by MTM", covered easy measuring of the work involved by means of MTM.

Art Metzger, Long Beach College, and Gentleman Farmer spoke on "MTM on the Farm"; new fields to conquer with MTM-Standards for truck farming (stoop labor and mechanized planting) an actuality.

Don Wheeler, Robertshaw-Fulton Controls Company discussed "MTM in the Foundry"; even in the heat of the foundry, MTM is at home, for measurement of shell molding, die casting as well as conventional pouring of green sand molds.

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## MTM PRESENTED TO N.A.C.A. CHAPTER

The subject "What is Methods-Time Measurement" was presented to the Ann Arbor, Michigan Chapter of National Association of Cost Accountants at the February 16, 1956 meeting.

D. W. Karger, Chief Plant and Industrial Engineer, The Magnavox Company, Fort Wayne, Indiana and R. F. Stoll, Executive Secretary, MTM Association, Ann Arbor addressed the group.

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## TRENTON, NEW JERSEY SAM CHAPTER HOLDS MTM CLINIC

Society for Advancement of Management, Trenton Chapter, conducted an all day MTM program Feb. 24, 1956 in Trenton, New Jersey.

Richard Robertson, Factory Manager, SKF Industries, gave the principle address on "Cost Reduction with MTM."

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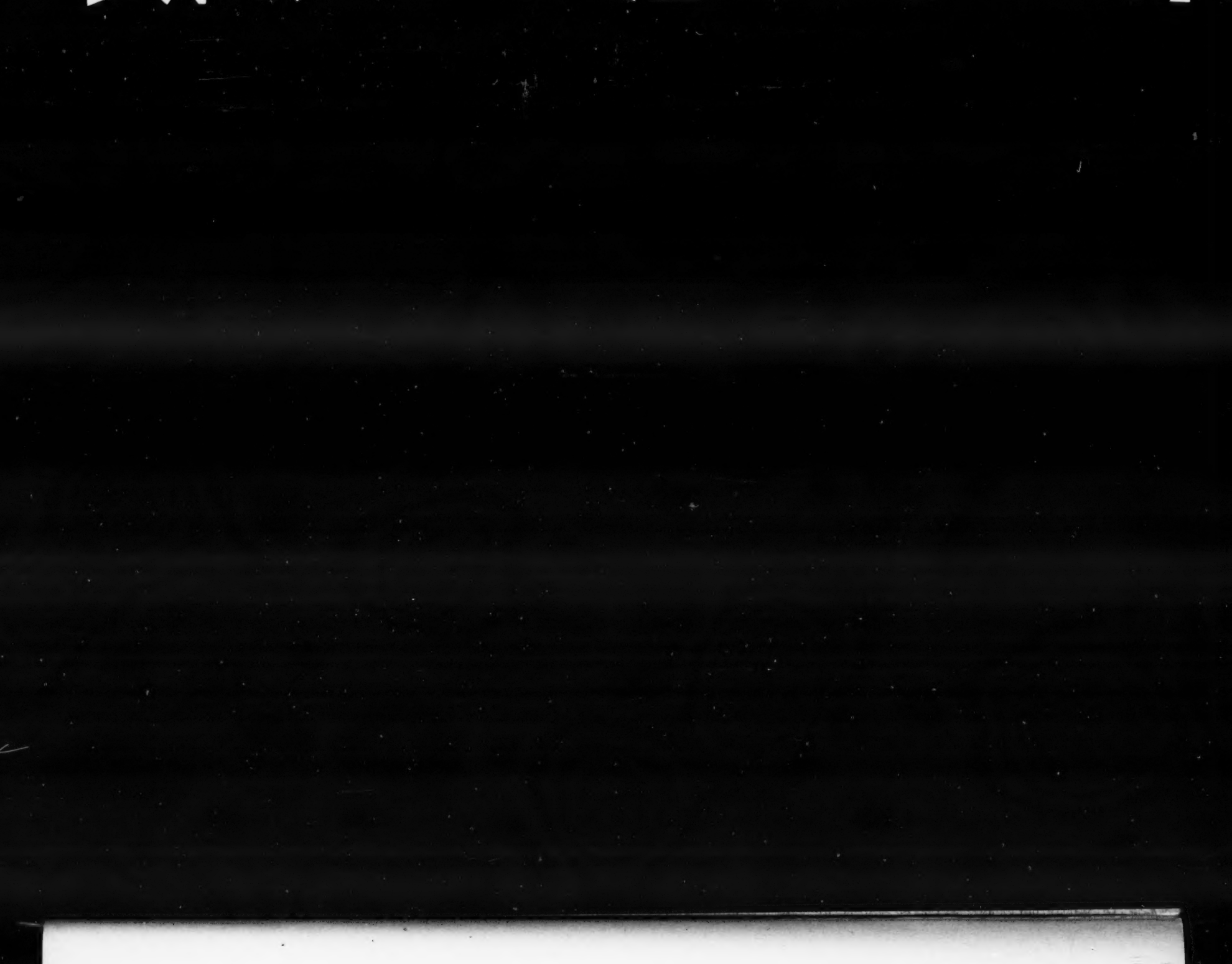

## RESEARCH REPORTS

R.R. 101 Disengage

This report contains a preliminary study of the element disengage. While it is still classified as tentative, the report contains some extremely interesting conclusions on the nature and theory of this element.

R.R. 102 Reading Operations

The first step in the use of MTM for establishing reading time standards is contained in this report. In addition, the report contains a synopsis of the work done in this field by 11 leading authorities.

R.R. 104 MTM Analysis of Performance Rating Systems

A talk presented at the SAM-ASME Time and Motion Study Conference, April 1952. It contains an analysis of performance rating systems and various performance Rating Films from an MTM standpoint.

R.R. 105 Simultaneous Motions

This report represents almost two man-years' work on a study of Simultaneous Motions. It is a final report of the Simultaneous Motions project undertaken by the MTM Association. While it does not purport to provide complete and exhaustive answers to all problems in the field of Simultaneous Motions, it presents a great deal of new and valuable information which should be of interest to every MTM practitioner.

R.R. 106 Short Reaches and Moves

This report contains an analysis of the characteristics of Reaches and Moves at very short distances. It develops important conclusions concerning the application of MTM to operations involving these short distance elements.

R.R. 107 A Research Methods Manual

The research activity of the Association has developed an effective and comprehensive set of methods for carrying on research in human motions. This report details the major techniques used. Adequate sources of motion data, film analysis, data recording, and statistical methods of analysis are among the topics discussed.

R.R. 108 A Study of Arm Movements Involving Weight

In this report, the results of a large investigation into the effect of weight on the performance times of arm movements are presented. While more effective means of determining correct time allowances for moving weights are given, the comprehensive discussion of the whole area of weight phenomena is probably of more fundamental importance. The effect of such conditions of performance as the use of one or two hands, sliding vs. spatial movements, and male and female performance are among the topics presented.